



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ON SOME DINICHTHYID ARMOR PLATES FROM THE MARCELLUS SHALE

BURNETT SMITH
SYRACUSE UNIVERSITY

INTRODUCTION

THOUGH Devonian beds in many parts of the world frequently furnish an abundance of piscine fossils, this is not the case with their cotemporaneous deposits of the state of New York. In this region every bit of evidence which may add to our knowledge of the anatomy, geographical distribution and geological range of the Devonian members of the class may at any time become of interest, for amid profuse invertebrate faunas the fish remains are usually rare, inconspicuous and fragmentary.

It is, therefore, believed that a recent find of the complete ventral armor¹ (together with some other bones) of a small species of *Dinichthys* is worthy of some notice in spite of the fact that the preservation leaves much to be desired and also that any interpretations based on the material are apt to prove untenable when more complete and more perfectly preserved specimens are brought to light.

DESCRIPTION OF THE FIGURES

The specimen in question came from the concretion zone of the Marcellus Shale in the vicinity of Syracuse, N. Y., and was collected by the writer in the summer of 1908. Its geological horizon is not determinable with absolute certainty, but it lies not far (within fifteen feet at most) above the top of the Agoniatites Limestone, which in this section is itself confined to the lower fifteen

¹ The writer must express his indebtedness to Dr. Louis Hussakof and to Dr. Charles R. Eastman, both of whom generously examined the photographs of this specimen and gave him invaluable assistance in the interpretation of its osteology.

or twenty feet of the Marcellus Shale formation. The geological position of the specimen together with its size and the character of its external ornamentation points strongly to its identity with *Dinichthys halmodaeus* (Clarke).² It is realized perfectly that this identification may prove incorrect but for purposes of convenience the specimen will throughout this paper be considered as belonging to that species.

The fossil occurs as a probable nucleus for one of the large concretions, though its position in the mass is ex-central. It has been laid bare by the removal of a part of the concretion and apparently has been subjected to weathering for a considerable time. This has resulted in the loss of nearly all of the external ornament, only one or two small patches of bone exhibiting the superficial tuberculation. How much of the skeleton has disappeared with the missing portion of the concretion it is impossible to say, for diligent search has failed to reveal its presence in the immediate neighborhood.

The concretions at this horizon are crossed by at least two sets of irregular planes of fracture which have been infiltrated with barite, calcite and other minerals. We, therefore, have (1) lines crossing the specimen which are incident to the formation of the concretion itself, (2) lines of fracture in the fossil which are independent of structural features and (3) the lines which mark the boundaries of the different bones. This fact is mentioned here in order to call attention to the many lines in the accompanying photograph (Fig. 1) which must be distinguished from those which represent organic structures.

As stated before, the parts preserved are: (1) the nearly complete ventral armor with its elements in natural association and (2) other scattered bones among which a postero-dorsolateral and an antero-dorsolateral stand out conspicuously (see Figs. 1 and 2).

The Ventral Shield.—In the median region the antero-

² *Coccosteus* (?) *halmodaeus* Clarke. John M. Clarke. New and Rare Species of Fossils from the Horizons of the Livonia Salt Shaft. Report State Geologist, N. Y., 1893, p. 161.

ventromedian is well preserved posteriorly, but its anterior portion has been broken away. The impression of this missing part is, however, well preserved on the surface of the matrix and there is no difficulty in restoring the outline of this plate on its forward margin. Posteriorly it meets the postero-ventromedian, the limits



FIG. 1. *Dinichthys halmodaeus* (?) (Clarke). Photograph (not retouched) of the ventral shield with associated bones. The long axis of the elliptical surface on which the specimen is exposed measures about 34 cm.

of the two plates being indicated by a curved line whose convex side is directed forward. The postero-ventromedian is clearly outlined, though its surface has been considerably crushed. The antero-ventrolaterals border the two median plates on either side. It is impossible

to make out the exact limits of their inner margins on account of the weathering to which they have been subjected. They lie in a plane higher (more ventral anatomically) than the median plates and undoubtedly overlapped them slightly. On the posterior lateral borders

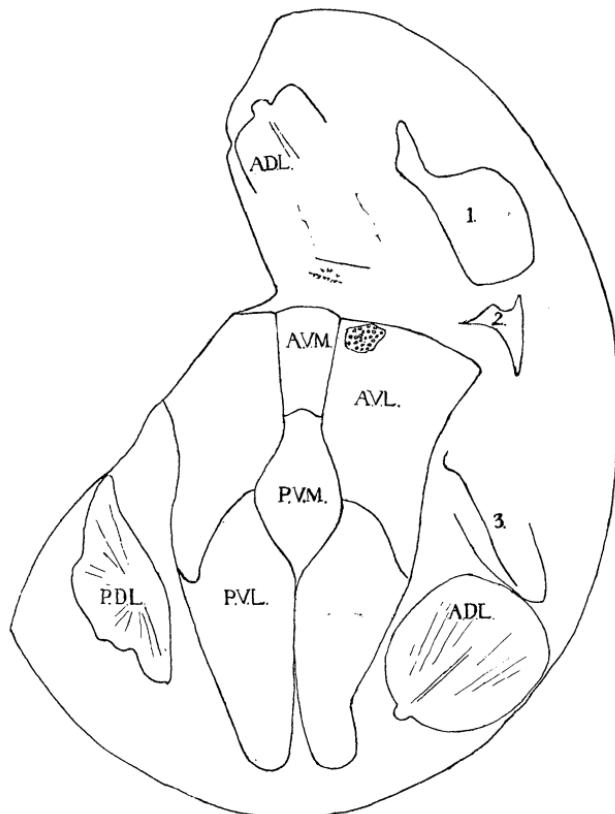


FIG. 2. *D. halmodicus* (?) (Clarke). Drawing made from a tracing of the photograph shown in Fig. 1. *AVM*, antero-ventromedian; *PVM*, postero-ventromedian; *AVL*, antero-ventrolateral; *PVL*, postero-ventrolateral; *PDL*, postero-dorsolateral; *ADL*, antero-dorsolateral; 1, suborbital?; 2, antero-supernuchal?; 3, possibly a fragment of the dorsomedian.

of the postero-ventromedians lie the two postero-ventrolaterals. The inner margins of these plates are also hard to delimit. They were overlapped by the antero-ventrolaterals, for they lie at a lower (anatomically more dorsal) plane. The inner margins of all four of the lateral plates

are believed to have been broken or to have weathered away. If this is the case we have exposed the actual lateral outlines of the two median plates. The shape of the entire ventral shield is quite accurately indicated by the outer margins of its constituent plates in spite of fracturing and some displacement. The left antero-ventrolateral still retains a small patch of the exterior surface showing a tuberculation similar to that of a *Dinichthys* cranium from Manlius, N. Y., which has been referred by Eastman to *D. halmodeus*.³ A few obscure tubercles are also present on the left postero-ventrolateral. As exhibited in this specimen the two median plates appear to be quite flat. The antero-ventrolaterals are much crushed, but apparently were slightly convex on their ventral surfaces. The postero-ventrolaterals show convexity on their outer or ventral surfaces.

Bones without the Ventral Shield.—The most conspicuous of these are the postero-dorsolateral and the antero-dorsolateral. The former of these is flat, and though it is much weathered, it appears to furnish us with about the outline of the original plate. The latter is decidedly convex and though much weathered it shows the articular projection and the canal.

Above (forward of) the ventral shield is a confused mass of bones, some of them exhibiting sharp tooth-like denticles, while beyond this again is another poorly preserved antero-dorsolateral exhibiting both the canal and the articular projection. No cranial plates can be made out with certainty, though the bone marked 1 in Fig. 2 might be interpreted as a suborbital, while at 2 is a bone suggesting an antero-supero-gnathal.

COMPARISON WITH OTHER SPECIMENS

As far as the author knows, only two other specimens of *Dinichthys* with the ventral armor plates in natural association have been recorded. The first specimen was

³ *N. Y. State Museum Memoir*, 10, p. 128, pl. 10.

described by Von Koenen⁴ and referred with doubt to *D. minor*. In this case the material was too poorly preserved to admit of the exact determination of the different bones. In the second specimen the preservation is quite satisfactory and we are indebted to Dr. Eastman⁵ for its description. He has referred it tentatively to

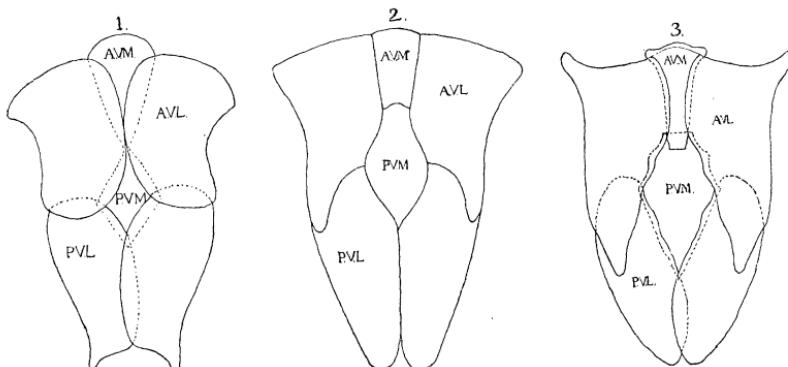


FIG. 3. 1, restoration of the ventral shield of *Coccostetus decipiens* Ag. (modified from Smith Woodward). 2, restoration of the ventral shield of *Dinichthys halmodicus* (?) (Clarke), no attempt being made to indicate overlap. 3, restoration of the ventral shield of *D. newberryi* (?) Clarke (after Eastman). Bones lettered as in Fig. 2.

D. newberryi Clarke. This latter example shows all six of the ventral plates but little removed from the original position. In his restoration Dr. Eastman illustrates the conditions of overlap and brings the bones into the positions which it is believed they occupied in life.

Comparing now (Fig. 3) the restoration of *D. newberryi* (?) with that here regarded as *D. halmodeus* it will be seen that in each case the antero-ventrolateral overlaps the postero-ventrolateral and that all four ventro-laterals overlap the two median plates. When, however, the relations of the two medians are considered we are unable to carry the comparison farther. In *D.*

⁴ A. von Koenen. Ueber einige Fischreste des norddeutschen und böhmischen Devons. *Abhandl. K. Gesell. Wissenschaft. Göttingen*, Vol. XL, pp. 1-37, Plates I-IV, 1895.

⁵ C. R. Eastman. On the Relation of Certain Plates in the Dinichthyids. *Bull. Mus. Comp. Zool. Harvard*, Vol. XXXI, October, 1897, pp. 26 and 27, Plate I, fig. 2 and Plate IV.

newberryi (?) the antero-ventromedian overlaps the postero-ventromedian. In the present specimen we can not prove that some overlap did not occur, for the point of junction is much eroded. We can, however, say that no such overlap is indicated and that the two plates appear to be separated by a thin curved suture which is convex anteriorly and concave posteriorly.

When the postero-ventrolaterals are compared with those of *D. newberryi* (?) the general outlines and proportions exhibit great similarity, but this is not the case with the antero-ventrolaterals. In these plates not only is there an apparent difference in the posterior overlapping margins, but the anterior lateral projection is turned posteriorly and not anteriorly as in *D. newberryi* (?). This gives the entire front margin of the ventral shield an evenly convex outline quite different from the bow-shaped line shown by *D. newberryi* (?) and in Hussakof's⁶ restoration of *D. curtus*. As a whole the ventral shield exhibits general relations of length to breadth not unlike that of *D. newberryi* (?) but is proportionately much broader and stouter than the restored plastron of *D. curtus* to which reference has been made.

COMPARISON WITH COCCOSTEUS

All authorities on the Arthrodira have united in assigning to *Dinichthys halmodaeus* a primitive position among American Dinichthyids and the species is regarded as having diverged only slightly from the ancestral genus Coccosteus. These relationships have been made out by studies on the cranium, the infero-gnathals and on the dorsal body plates.

If then the specimen here considered is indeed specifically identical with *D. halmodaeus* we have further confirmation of the practically intermediate position which the species holds between Coccosteus on the one hand and the highly specialized species of Dinichthys on the other.

⁶ L. Hussakof. On the Structure of Two Imperfectly Known Dinichthyids. *Bull. Am. Mus. Nat. Hist.*, Vol. XXI, Art. XXV, p. 412.

That the ventral armor of the present specimen belonged to a primitive type is shown: (1) by the fact that the antero-ventromedian and postero-ventromedian are not fused as in such specialized forms as *D. terrelli*⁷ and (2) by the fact that the anterior lateral angles of the antero-ventrolaterals are directed posteriorly giving this portion of the ventral shield an outline similar to that of *Coccosteus* (see Fig. 3).

The fact that the antero- and postero-ventromedians are united by suture and not merely touching or even separate shows an advance from the condition of these elements in *Coccosteus*, but taking the sum of the characters in the ventral shield we have, on the whole, a closer approximation to this latter genus than to *Dinichthys*.

DISTRIBUTION OF DINICHTHYS IN THE NEW YORK PROVINCE

In his recent memoir⁸ Dr. Eastman lists eight species of *Dinichthys* as occurring in the Devonian of the New York-Pennsylvania Province. Of these six are confined to the upper Devonian, that is, they are found only above the top of the Hamilton shales. Of these, three at least are common to both the New York-Pennsylvania and the Ohio province, while three appear to be restricted to the New York-Pennsylvania province. The Middle Devonian yields but two definite species, *D. lincolni* Claypole and *D. halmodeus* (Clarke). Both are, as far as known, restricted to the Marcellus division of the Middle Devonian. *D. lincolni* is known by a single tooth found in the upper part of the Marcellus Shale twenty-five feet below the basal limestone of the Hamilton. *D. halmodeus* is, according to the same authority, known by three specimens: (1) the type cranium, (2) a dorsomedian plate associated with the type cranium and possibly belonging to the same individual and (3) a cranial fragment. The

⁷ See Hussakof's figures, *Mem. Am. Mus. Nat. Hist.*, Vol. IX, pt. III, p. 139.

⁸ *N. Y. State Mus. Mem.*, 10, 1907.

type material is reported by its original describer as having come from the Livonia salt shaft, Livingston County, N. Y., and its geological horizon is about forty feet above the base of the Marcellus Shale. It lies just below the Stafford Limestone bed of the Marcellus in a black shale and its associates make a typically Marcellus assemblage. Among them are such invertebrates as *Orthoceras subulatum*, *Styliolina fissurella*, *Chonetes mucronatus*, *Leiopteria laevis* and *Leiorhynchus limitaris*.⁹ The cranial fragment figured by Dr. Eastman¹⁰ is reported as having come from the Agoniatites Limestone, Hendrick's Ledge, west of Manlius, Onondaga County, N. Y.

The Agoniatites Limestone in Onondaga County lies about thirteen feet above the base of the Marcellus formation, is about two and one half feet thick and is both underlaid and overlaid by the black friable Marcellus shales.¹¹ The specimen which has been the subject of this brief paper was found in a limy concretion from the upper black shale above the Agoniatites Limestone and probably within ten feet of it. At this point both the shales and the concretions are alike very poor in fossils, none having been found in the shale and a single Ichthyodorulite being the only yield from an examination of many other concretions.

From the evidence of stratigraphy it appears that the limestone lentils of the Marcellus shales are the expressions of changing geographical conditions and invading faunas.¹² They are not everywhere at the same geological horizons with relation to the base of the Marcellus, and as they represent invasions the limestone in one locality may be cotemporaneous with shale in a different

⁹ D. D. Luther. *Report on the Livonia Salt Shaft*. Rep. State Geol. N. Y., 1893, p. 81.

¹⁰ *New York State Mus. Mem.*, 10, pl. 10.

¹¹ John M. Clarke. Marcellus Limestone of Central and Western New York and their Faunas. *N. Y. State Mus. Bull.*, 49.

¹² *N. Y. State Mus. Bull.*, 82, p. 43. The Agoniatites Limestone does not lie between the Marcellus and Cardiff shales as Dr. Eastman has inadvertently stated on p. 129, *N. Y. State Mus. Mem.*, 10.

locality. These limestones then give us the history of areas in the old Marcellus sea which were covered from time to time by invading faunas. It is natural therefore that we should find a species of *Dinichthys* probably one of the most mobile animals of the time associated: (1) in one locality with the large cephalopods of the *Agoniatis* Limestone, (2) in another with the small brachiopods and pelecypods of the typical black shale and probably not far from an area occupied by the Stafford fauna and (3) in the unfossiliferous black shale from which the present specimen came.

In his paper cited above Dr. Clarke brings out evidence to show that the *Agoniatis* Limestone and some of the lower Marcellus black shale in central and eastern New York is the time equivalent of some of the upper Onondaga of the western portion of the state. This lends a peculiar interest to the Onondaga County specimens of *D. halmodaeus* which coming as they do from the lower Marcellus lived in a muddy portion of the great New York embayment at no great distance from an area to the west in which Onondaga Limestone conditions prevailed. It is therefore not unreasonable to expect that *D. halmodaeus* or some very closely related form may in time be found in the upper Onondaga deposits of this latter region.